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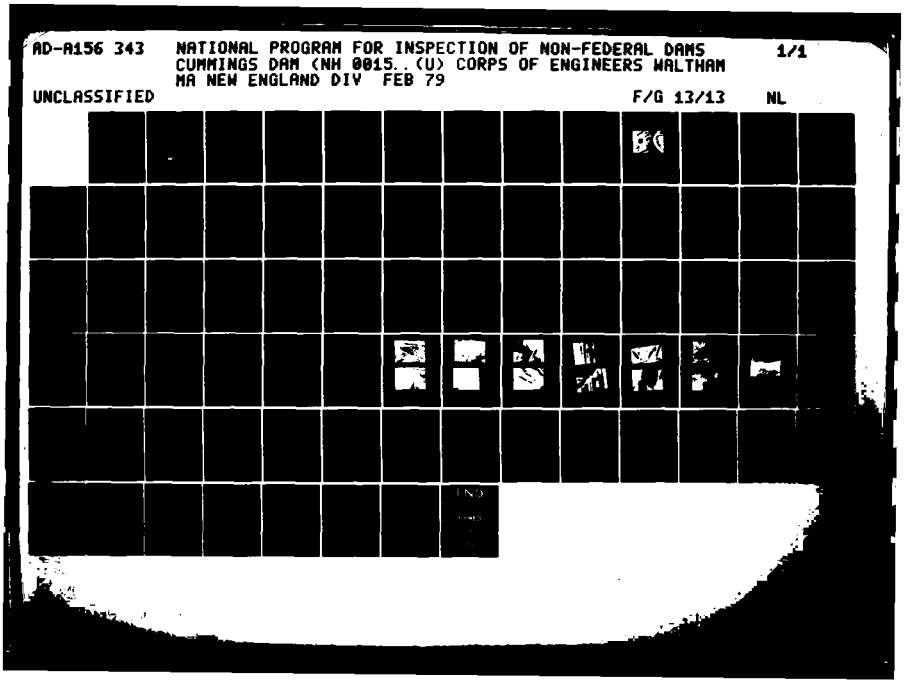

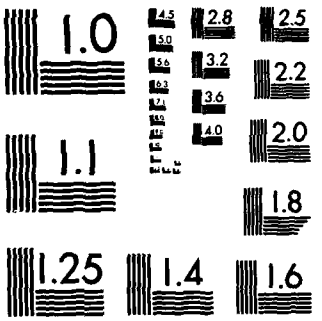

MICROCOPY RESOLUTION TEST CHART
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CONNECTICUT RIVER BASIN
LEBANON, NEW HAMPSHIRE

CUMMINGS DAM
NH 00154

STATE NO 134.05

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

FEBRUARY 1979

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NH 00154	2. GOVT ACCESSION NO. AD A156343	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Cummings Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		12. REPORT DATE February 1979 13. NUMBER OF PAGES 49
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Connecticut River BAsin
Lebanon, New Hampshire
Mascoma RIver

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam has a hydraulic height of 16.5 ft. and is 110 ft. long. THe dam is in poor condition, with a few major concerns which should be corrected. It is small in size with a significant hazard potential classification.

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NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:

NEDED

Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Dear Governor Gallen:

I am forwarding to you a copy of the Cummings Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, E. Cummings Leather Company, Inc., Lebanon, New Hampshire 03766.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Water Resources Board for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.: NH00154
Name of Dam: Cummings Dam
City: City of Lebanon
County and State: Grafton County, New Hampshire
Stream: Mascoma River
Date of Inspection: November 8, 1978

BRIEF ASSESSMENT

Cummings Dam has a hydraulic height of 16.5 feet, is about one foot wide at the crest, and is 110 feet long. It is a run-of-the-river, timber-frame and deck dam; the spillway is 103 feet long with a single-timber crest and 4-inch plank deck sloping about 2H:1V upstream. The dam spans a reach of the Mascoma River, and is located in west central New Hampshire. It has two low-level outlet gates and an intake gate to a leather plant. Maximum storage capacity is about 80 acre-feet. Cummings Dam is used for industrial process water. The pond ranges from 0.6 to 0.8 miles in length with a surface area of about 8 to 12 acres.

The dam is in poor condition. Major concerns are: the badly deteriorated and missing or fallen structural timbers; the rusted, broken, loose, missing, and disconnected bolts and dogs; deteriorated, broken or missing decking; the dependence upon frictional anchorage of sills to rounded boulders and both of these to the rounded bedrock downstream; the severely cracked and spalled concrete and the silt accumulation on the decking.

Based on small size and significant hazard potential classification, in accordance with Corps guidelines, the test flood is 1/4 Probable Maximum Flood. A 1/4 PMF outflow of 15,050 cfs (about 88 csm) would overtop the dam by 7.4 feet (10.6 feet over the spillway crest). The spillway might pass 2240 cfs or about 15 percent of the test flood. A major breach at top of dam would probably result in the loss of no lives but cause appreciable property damage.

The owner, E. Cummings Leather Company, should implement the results of the recommendations and remedial measures given in Sections 7.2 and 7.3 respectively, within one year after receipt of this Phase I inspection report.

Warren A. Guinan
Project Manager
N.H. P.E. 2339

This Phase I Inspection Report on Cummings Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

JOSEPH A. MCELROY, CHAIRMAN
Chief, NED Materials Testing Lab.
Foundations & Materials Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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Figure 1 - Overview of Cummings Dam.

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SCALE IN MILES

0 5 10

MAP BASED ON STATE OF NEW HAMPSHIRE OFFICIAL HIGHWAY MAP.

Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

CUMMINGS DAM
LOCATION MAP

MASCOMA RIVER NEW HAMPSHIRE

SCALE:	SEE BAR SCALE
DATE:	FEBRUARY 1979

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
CUMMINGS DAM

SECTION I
PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Anderson-Nichols & Company, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to Anderson-Nichols & Company, Inc. under a letter of November 20, 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0009 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) To encourage and prepare the states to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify, and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. Cummings Dam is located in the City of Lebanon, New Hampshire. The dam is a run-of-the-river dam spanning the Mascoma River, a major tributary of the Connecticut River. After discharging over Cummings Dam, the Mascoma River flows westerly for a distance of about 5 miles before becoming confluent with the Connecticut River. The dam is shown on U.S.G.S. Quadrangle, Hanover, Vermont-New Hampshire with coordinates approximately at N 43° 38' 36", W 72° 15' 18", Grafton County, New Hampshire. (See Location Map page vii.)

b. Description of Dam and Appurtenances. Cummings Dam is an industrial water supply dam for the E. Cummings Leather Company, Inc. The dam is a timber frame and deck placed

between vertical concrete walls. Cummings Dam is a run-of-the-river dam with a spillway that is about 103 feet long. To the east of the east abutment is a 30-foot section of natural ground that ends at a vertical concrete highway retaining wall. From the east abutment a fractured concrete wall follows the stream upstream to high ground that ends at the vertical concrete highway retaining wall. At the west side of the spillway there is a 7-foot long abutment which includes a gate that was used as an inlet to the penstock entering the mill. To the west of the abutment is the E. Cummings Leather Company, Inc. building.

c. Size Classification. Small (hydraulic height - 16.5 feet; storage - 80 acre-feet), based on hydraulic height and storage (< 40 feet and ≥ 50 to < 1000 acre-feet) as given in Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. Significant hazard. A major breach in the dam would probably result in no loss of life but appreciable property damage. (See Section 5.1 f.)

e. Ownership. The dam now referred to as Cummings Dam was built around 1887 by the Everett Knitting Works for use in their milling operations. Ownership passed to the E. Cummings Leather Company, Inc. in 1939.

f. Operator. E. Cummings Leather Company, Inc., Lebanon, New Hampshire 03766 is responsible for the operation of the dam. Telephone (603) 448-3125.

g. Purpose of Dam. The dam was probably originally constructed to provide storage to produce water power for the Everett Knitting Works. Under the ownership of E. Cummings Leather Company, it was used to provide storage for hydroelectricity and industrial process water for the tannery. The dam is presently being used to provide process water to the tannery.

h. Design and Construction History. Little information was disclosed concerning the original design and construction of the dam. A few sketches were found in the files of the New Hampshire Water Resources Board (NHWRB). (See Appendix B.)

When the Cummings brothers took over the mill in 1939, the dam was repaired and the gates on the east end of the spillway were removed. The spillway was then lengthened to the abutment. The repairs included replacing rotten timbers in existing bents, adding new bents, and replanking the entire dam with new four-inch thick timbers.

i. Normal Operational Procedures. No formal operation and maintenance procedures were disclosed. The pool elevation varies only with the amount of discharge in the river. E. Cummings Company uses about 3/4 mgd (1.2 cfs) for process water.

1.3 Pertinent Data

a. Drainage Area. The drainage area consists of 172 square miles (110,080 acres) of predominantly wooded terrain.

b. Discharge at Damsite.

(1) Outlet works (conduits) - Two low-level outlets 8' H x 3.75' W @ invert elevation 562.9' MSL. Combined gate capacity at top of dam - 730 cfs @ 571.6' MSL.

(2) The maximum discharge at damsite - a U.S.G.S. gaging station with a drainage area of 153 square miles is located on the Mascoma River near Mascoma, New Hampshire. A maximum discharge of 5840 cfs was recorded at this gaging station during the March 1936 flood. Using this figure, the maximum discharge at damsite can be interpolated to be about 6375 cfs.

(3) Ungated spillway capacity @ top of dam elevation - 2,240 cfs @ 571.6' MSL

(4) Ungated spillway capacity @ test flood elevation - 13,510 cfs @ 579.0' MSL

(5) Gated spillway capacity @ top of dam elevation - not applicable

(6) Gated spillway capacity @ test flood elevation - not applicable

(7) Total spillway capacity @ test flood elevation - 13,510 cfs @ 579.0' MSL

(8) Total project discharge @ test flood elevation - 15,050 cfs @ 579.0' MSL

c. Elevation. (ft. above MSL based on elevation of top of spillway recorded in data obtained from NHWRB).

(1) Streambed at centerline of dam - 555.1 (downstream toe)

(2) Maximum tailwater - with an estimated maximum discharge of 6375 cfs during the March 1936 flood, maximum tailwater could be estimated to have been 564' MSL.

(3) Upstream invert low-level outlet-562.9

(4) Recreation pool - not applicable

(5) Full flood control pool - not applicable

(6) Spillway crest - 568.4

(7) Design Surcharge (Original Design) - Unknown

(8) Top of Dam - 571.6

(9) Test flood pool - 579.0

d. Reservoir (miles)

(1) Length of maximum pool - 0.8

(2) Length of spillway crest pool - 0.6

(3) Length of flood control pool - not applicable

e. Storage (acre-feet)

(1) Recreation pool - not applicable

(2) Flood control pool - not applicable

(3) Spillway crest pool - 45 (approximate)

(4) Top of dam - 80 (approximate)

(5) Test flood pool - 235 (approximate)

f. Reservoir Surface (acres)

(1) Recreation pool - not applicable

(2) Flood control pool - not applicable

(3) Spillway crest - 8 (approximate)

(4) Test flood pool - 20 (approximate)

(5) Top of Dam - 12 (approximate)

g. Dam

(1) Type - timber frame, wood decking, between concrete abutments

(2) Length - 110'

(3) Height - 20' (structural)

(4) Sideslope - vertical downstream; approximately 2H:1V upstream

(5) Top width - approximately 1' (log crest)

(6) Zoning - not applicable

(7) Impervious core - not applicable

(8) Cutoff - none

(9) Grout curtain - none

h. Diversion and Regulating Tunnel - Not applicable (See j. below)

i. Spillway

(1) Type - ungated (run-of-the-river)

(2) Length of weir - 103'

(3) Crest elevation - 568.4' MSL

(4) Gates - none

(5) U/S Channel - Mascoma River, bedrock covered with silt, banks lightly covered with brush and trees.

(6) D/S Channel - The channel immediately downstream of the dam is covered with rocks. The south valley side is covered with rocks along the river and trees and brush further up the bank. On the north valley side the mill building is along the edge of the stream.

j. Regulating Outlets. No gates are in operation at the present time. The gates (two 8' H x 3.75' W gates) at the west side of the spillway have mechanical lifting devices in place but are not operated.

SECTION 2
ENGINEERING DATA

2.1 Design

No original design data were disclosed for Cummings Dam.

2.2 Construction

No construction data is available prior to 1939. Extensive repairs were done in 1939 by Granite State Construction Company. (See Section 1.2.h.)

2.3 Operation

No engineering operational data were disclosed.

2.4 Evaluation

a. Availability. Little engineering data were disclosed for Cummings Dam. A search of the files of the New Hampshire Water Resources Board revealed only a limited amount of recorded information. (See 2.4.c. below.)

b. Adequacy. Because of the limited amount of detailed data available, the final assessments and recommendations of this investigation are based on the visual inspection and hydrologic and hydraulic calculations.

c. Validity. A single sketch appears to have been related to an earlier version of the structure which is different than the existing dam. A single plan was found that does relate to the dam and was found to be reliable in the details presented.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Cummings Dam is a low run-of-river dam which impounds a reservoir of small size; its overall size classification is small. The watershed above the dam is rolling and partially covered with forest. The dam is located in the center of the City of Lebanon, N.H., on the Mascoma River about 5 miles upstream from its confluence with the Connecticut River. There are several dams on the Mascoma River upstream and downstream of Cummings Dam.

b. Dam. Cummings Dam is a timber frame dam with plank facing on the upstream side. It is about 20 feet high and 110 feet long. (See Appendix C - Figure 2.) At the time of the inspection, the reservoir level was 1.6 feet below the crest of the dam, and the entire flow of the river was leaking through the dam. (See Appendix C - Figures 3, 4, 5 and 6.)

Much of the timber (approximately 12" x 12") that comprise the principal structural elements of the dam are very badly deteriorated, some have fallen, and some are missing. (See Appendix C - Figures 7, 8, 9 and 10.) Many of the large bolts and metal dogs that fasten the timbers together are badly rusted, loose, or missing. (See Appendix C - Figure 11.) The plank facing on the upstream side of the dam is badly deteriorated. Leakage through the plank facing is occurring over the entire length of the dam; at the east end of the dam there is a slowly moving whirlpool above one of the areas of greatest leakage. (See Appendix C - Figure 4.) The dam rests on a bedrock foundation. Several of the timbers at the base of the dam are resting on large boulders which in turn rest on the rounded, downstream-sloping bedrock surface. Although these boulders were apparently placed deliberately to provide a horizontal base for the dam, and have presumably been in place for many years, they appear to be only marginally stable. (See Appendix C - Figure 2.) In the limited areas that could be safely inspected, there was no mechanical anchorage of the timber dam to the rock foundation. Numerous steel pins were observed embedded in the rock under the dam; however none appeared to be connected to the support timbers for anchorage. It appears the friction between the timbers and rock provides the only resistance against sliding of the dam. The crest of the dam bulges downstream approximately one foot near the center of the dam, as estimated visually from a point on the east abutment. (See Appendix C - Figure 3.)

Silt has filled the reservoir to an elevation a few feet below the crest of the dam. In addition, there are some leaves, sticks and other debris accumulated behind the dam, especially near the two abutments. (See Appendix C - Figures 3 and 4.)

The concrete training wall at the east abutment is severely cracked and spalled. (See Appendix C. - Figure 12.)

c. Appurtenant Structures. A concrete inlet structure at the west end of the dam, adjacent to the mill building, acts as a low-level outlet to the dam and intake for process water to the mill buildings. (See Appendix C - Figures 3 and 4.) The visible portions of the downstream face are cracked, spalled and numerous areas stained with efflorescence. No indications of movement or instability were observed. The exposed concrete foundation wall of the mill building immediately upstream of the inlet structure has been undermined. The concrete is spalled and cracked in numerous places. The wooden sluice gate located approximately two feet below the crest is badly deteriorated and the concrete guides are badly spalled and deteriorated. The mechanical gate operating mechanism appeared to be in fair condition.

d. Reservior Area. The reservoir is partly within the City of Lebanon and extends a short distance upstream along the Mascoma River Valley. (See Appendix C - Figure 13.) The watershed above the reservoir is rolling and is forested. As mentioned above, the reservoir is filled with silt to an elevation a few feet below the crest of the dam.

e. Downstream Channel. The channel immediately downstream of the dam is bedrock with some large boulders. There is a railroad bridge and a highway bridge across the valley a few hundred feet downstream of the dam. (See Appendix C - Figure 14.) A number of mill buildings are located on either side of the valley downstream of the dam. Several dams are located between Cummings Dam and the confluence of the Mascoma River with the Connecticut River about 5 miles downstream.

3.2 Evaluation. Based on the visual inspection, Cummings Dam is considered to be in poor condition. The timber dam itself is so badly deteriorated that it may collapse at any time, more likely with a spring freshet. When the dam does collapse, the quantity of water that will be released is relatively small, because the reservoir is nearly filled with silt. A large volume of silt might be carried downstream immediately after the dam failed, and there might be

smaller quantities of silt eroded from the reservoir and carried downstream over a period of months or years. The silt itself may contain pollutants, if any were dumped in the river in years past. Pollutants could cause significant environmental problems downstream if the dam were breached, either accidentally or deliberately.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

The E. Cummings Leather Company, Inc. has operated the dam since 1939. At the present time, no formal operational procedures exist.

4.2 Maintenance of Dam

Cummings Dam is maintained by E. Cummings Leather Company, Inc. No formal maintenance schedule is followed.

4.3 Maintenance of Operating Facilities

Operating facilities are maintained by E. Cummings Leather Company, Inc.

4.4 Description of Any Warning System in Effect

No written warning system was disclosed for Cummings Dam.

4.5 Evaluation

Because of the deteriorated condition of the dam, the present assessment reflects major problems that are not amenable to simple operating and maintenance procedures. The E. Cummings Leather Company, Inc. should establish a surveillance and warning program to follow in the event of flooding and imminent dam failure. An alternative approach would be to select a time and dismantle the dam.

SECTION 5
HYDROLOGY AND HYDRAULIC ANALYSIS

5.1 Evaluation of Features

a. General. Cummings Dam is a run-of-the-river, low timber frame and deck dam which impounds a reservoir of small size. The timbers that comprise the principal structural elements of the dam are very badly deteriorated. Based on the visual inspection, the dam is in poor condition and could collapse at any time.

b. Design Data. No original hydrologic and hydraulic design data were found for the dam.

c. Experience Data. Although no recorded experience data were disclosed, the known flood of record occurred in 1936 on the Mascoma River. Based on the U.S.G.S. gage upstream of Cummings Dam, a discharge of 6375 probably occurred at the dam. This is equivalent to 42 percent of the test flood. The effects of the 1936 flood on the dam and the subsequent 1938 flood, though of lesser magnitude, can only be surmised to have been severe; the dam was renovated in 1939.

d. Visual Observations. At the time of inspection, visual evidence was noted of damage to the dam. The damage was caused over a long period of time by the normal flow conditions throughout the years and probably not by excessive discharges.

e. Test Flood Analysis. Cummings Dam is classified as being small in size having a hydraulic height of 16.5 feet and a maximum storage capacity of 80 acre-feet; the dam was determined to have a Significant Hazard classification. Using the Recommended Guidelines for Safety Inspection of Dams, the test flood was determined to be ½ of the Probable Maximum Flood (PMF).

The test flood discharge for Cummings Dam, having a drainage area of 172 square miles, was estimated to be 15,050 cfs based on guide curves developed by the Corps of Engineers for estimating peak discharges. The overtopping analysis indicates that the dam would be overtopped by 7.4 feet (10.6 feet over spillway crest) during the test flood. The maximum spillway capacity at top of dam is 2,240 cfs which is 15 percent of the test flood discharge.

f. Dam Failure Analysis. The impact of failure of the dam at normal flow conditions and at top of dam were assessed using the Guidance for Estimating Downstream Dam Failure

Hydrographs issued by the Corps of Engineers. The analysis covered the reach extending from the dam to the Slayton Hill Road Bridge, a distance of 0.9 mile. It was determined that a breach at top of dam would produce the greater downstream hazard. A breach at top of dam would result in an increase in stage of 2 feet in addition to the already high 6-foot tailwater. A breach would result in the loss of no lives, but could cause appreciable property damage to the mill foundation, the B&M Railroad and the Route 10 Highway Bridge piers and abutments.

One should note because of the lack of storage behind the dam, that test flood flows discharging over the dam, assuming the dam did not fail, would have nearly the same effects on the downstream hazard as a breach at top of dam.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Inspection. The following evidence of potential structural instability was observed during the visual inspection:

(1) Much of the timber that comprises the principal structural elements of the dam is very badly deteriorated.

(2) Many of the large bolts and metal dogs that fasten the timbers together are badly rusted, loose or missing.

(3) The plank facing on the upstream face of the dam is badly deteriorated, and the entire river flow is leaking through the dam.

(4) The timber structure is partially supported on large boulders which, in turn, rest on the rounded, downstream-sloping bedrock surface. No mechanical anchorages were noted between the timber dam and the bedrock.

(5) Silt has filled the reservoir to an elevation a few feet below the crest of the dam.

(6) The concrete training wall at the east abutment is severely cracked and spalled.

Based on the results of the visual inspection, it is considered that the dam could collapse at any time, however, this is more likely to occur during a spring freshet.

b. Adequacy of Information. The information available is such that the assessment of the dam must be based on the results of the visual inspection. The visual inspection is adequate to assess the condition of the dam.

c. Design and Construction Data. Available records indicate that Cummings Dam was built in 1887 and renovated in 1939. The date of construction on one data sheet dated January 3, 1938, is listed as 1923, but there is no other evidence in the available records to confirm this date. There is a letter dated May 3, 1922, indicating that there was a proposal to build a new dam downstream of the original dam, a drawing for a proposed concrete dam dated July 7, 1921, and a letter dated January 21, 1924, indicating that the proposal for a new dam was being shelved indefinitely

(See Appendix B.) No other information about the details of design and construction of the existing dam is available.

d. Operating Records. No operating records pertinent to the structural stability of the dam were disclosed.

e. Post-Construction Changes. Available records indicate that the dam was renovated in 1919. The renovation included replacement of timbers and the planking on the upstream face. In addition, the gates on the east side were removed and the spillway was continued to the concrete wall abutting the building which was subsequently removed.

f. Seismic Stability. This dam is in Seismic Zone No. 2 and in accordance with recommended Phase I Guidelines does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual inspection indicates that Cummings Dam is in poor condition and that it could collapse at any time. The major concerns with respect to the long-term stability of the dam are:

(1) Much of the timbers that comprise the principal structural elements of the dam are very badly deteriorated.

(2) Many of the large bolts and metal dogs that fasten timbers together are badly rusted, loose, or missing.

(3) The plank facing on the upstream face of the dam is badly deteriorated, and the entire river flow is leaking through the dam.

(4) The timber structure is partially supported on large boulders which, in turn, rest on the rounded, downstream-sloping bedrock surface. There appear to be no mechanical anchorages between the timber dam and the bedrock.

(5) The concrete training wall at the east abutment is severely cracked and spalled.

Also, the silt which has accumulated in the reservoir to an elevation a few feet below the crest of the dam may or may not contain pollutants that would cause environmental damage downstream when the dam fails.

b. Adequacy of Information. The information available is such that the assessment of the dam must be based primarily on the visual inspection. The visual inspection is adequate to determine the condition of the dam.

c. Urgency. The recommendations and remedial measures given in Sections 7.2 and 7.3 respectively, below, should be carried out within one year after receipt of this Phase I report.

d. Need for Additional Investigation. The results of the visual inspection are adequate to assess the stability of the dam. The only additional investigations required are those recommended in 7.2 below.

7.2 Recommendations

It is recommended that the Cummings Dam be removed within 1 year. A Registered Professional Engineer should be engaged to develop a procedure for removing the dam in such a way as to avoid damage downstream and damage to the buildings at the west abutment. Attention should be given to the silt that has accumulated in the reservoir and to its potential for causing environmental damage downstream.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. Because it is recommended that this dam be removed, there is no need to implement specific operational and maintenance procedures. It is recommended that a surveillance and warning system be established for use in event of flood flow conditions or imminent dam failure, although it should be recognized that the poor condition of this dam could lead to sudden collapse with little or no advance warning.

7.4 Alternatives. If a dam is needed at this site, a new one should be designed and built.

APPENDIX A

VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT Cummings Dam, N.H. DATE November 9, 1978

TIME AM

WEATHER Cool, sunny

W.S. ELEV. U.S. 566.8 DN.S. 555.1

PARTY:

1. Robert Langen (11/9 &11/15/78)
2. Stephen Gilman
3. Douglas Ford
4. Robert Ojendyk
5. Ronald Hirschfeld
6. David Deane
7. Warren Guinan (11/15/78)
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Hydrology/Hydraulics	W. Guinan/D. Ford/R. Langen	
2.	Soils & Geology	R. Hirschfeld	
3.	Structural Stability	S. Gilman	
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECKLIST

PROJECT Cummings Dam, N.H. DATE November 9, 1978

PROJECT FEATURE Outlet Works NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	Pool is approach channel.
Slope Conditions	No slopes.
Bottom Conditions	Extensive silting in upstream approach channel.
Rock Slides or Falls	None
Log Boom	None
Debris	Some leaves.
Condition of Concrete Lining	None
Drains or Weep Holes	None
b. Intake Structure	
Condition of Concrete	Visible surface eroded where in contact with water.
Stop Logs and Slots	None

PERIODIC INSPECTION CHECKLIST

PROJECT Cummings Dam, N.H. DATE November 9, 1978

PROJECT FEATURE Outlet Works - Control Tower NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	Wooden access stairs deteriorated and unsafe.
General Condition	Poor to fair. Concrete eroded where in contact with water.
Condition of Joints	No indication of movement.
Spalling	Downstream exposed face.
Visible Reinforcing	None
Rusting or Staining of Concrete	None
Any Seepage or Efflorescence	Exposed face - shows considerable.
Joint Alignment	No indication of movement.
Unusual Seepage or Leaks in Gate Chamber	Numerous cracks on exposed face showing seepage.
Cracks	Numerous surface cracks visible.
Rusting or Corrosion of Steel	Yes
b. Mechanical and Electrical	Gates not visible, gate mechanisms rusted on surface-no lubrication.
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIODIC INSPECTION CHECKLIST

PROJECT Cummings Dam, N.H. DATE November 9, 1978

PROJECT FEATURE Spillway NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	Timber structure with upstream plank facing acts as an overflow spillway.
a. Approach Channel	
General Condition	Timbers badly deteriorated; metal bolts, spikes, dogs, and the rods badly corroded
Loose Rock Overhanging Channel	None. Left bank riprap.
Trees Overhanging Channel	None. Few at right bank above dam.
Floor of Approach Channel	Badly silted up. Water depth not more than a few feet along left side of channel
b. Weir and Training Walls	
General Condition of Concrete	Fair
Rust or Staining	
Spalling	Yes on surface of training wall.
Any Visible Reinforcing	No
Any Seepage or Effloresceonce	Yes
Drain Holes	None visible.
c. Discharge Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Channel	Bedrock and boulders.
Other Obstructions	RR bridge with large pier, HW bridge and foot bridge timber debris on right side of channel under and downstream of RR bridge.

PROJECT Cummings Dam, N.H. DATE November 9, 1978

PROJECT FEATURE Reservoir NAME R. Langen

AREA EVALUATED	REMARKS
Stability of Shoreline	Good
Sedimentation	Considerable sedimentation ahong left upstream bank to highway bridge.
Changes in Watershed Runoff Potential	No significant changes.
Upstream Hazards	Commercial building upstream from HW bridge projects into stream. Lower level susceptible to damage.
Downstream Hazards	B&M Railroad and Route 10 Highway Bridge.
Alert Facilities	None
Hydrometeorological Gages	None
Operational & Maintenance Regulations	None posted.

APPENDIX B

ENGINEERING DATA

C125-C

MEMORANDUM

Case No. C125-C

TO: Mr. Richard S. Holmgren, Chief Engineer

RE: Mascoma River at Lebanon - Cummings Company

Visited the construction at Lebanon on September 19, 1939 and at that time contacted Mr. Horton the Contractor and Mr. Cummings the owner.

The dam has been completed as originally specified in so far as replacement of timbers and planking. The spillway type of construction was continued between the old bulk head on the south east side and bents placed. It was my understanding that the old gate structure was to be removed, the concrete wall abutting the building (grain mill) was to be continued thereby giving additional spillway and the wall furnishing protection to the building below by diverting the water towards the center of the stream. Upon inspection, the dam was found to be very well constructed and totally completed with the exception of the three main upright timbers of the old headworks having been left in place and tied to the front upright member of the bent. The distance from the normal spillway to the top of these uprights has been planked. This brings this section to the height of the old lower concrete wall, and places the structure back in its original condition. I suggested to Mr. Cummings that some form of protection should be made for the building below and suggested that the concrete wall be continued. He and Mr. Horton suggested that they be allowed to tie on to the present uprights at this section and continue a wooden planked abutment to the height of the concrete wall at the building. I told them that I would make known their requests to you. The owner of the grain mill pointed out to me a mark on the wall of the building which is approximately 2 inches below the wall which he maintains was the high water mark in 1936. However, subsequent computations of the actual flow would tend to show that the water exceeded this height. There is a

C/25-C

low place between the northeast end of the grain mill and the next building up river which was sand bagged during both floods. There is a very poor temporary plank barrier now placed across this opening which at the present time furnishes a foundation for sand bagging but probably would not last more than a couple of years. I suggested that this opening be protected by a suitable concrete wall. In the event of another flood, there is danger that water backs up from the dam and flood the buildings and ~~weed~~ FLOW down the Main Street.

I called on Mr. Norris Cotton who is advisor for Mr. Cummings but he was out of town. For his information, I explained the situation to his Secretary. I would suggest that you talk with Mr. Cotton personally and I am quite sure Mr. Cummings would take his advise and complete the structure as requested.

Although the work that was done was very well done, specifications and plans did not reach this office until completion of the structure.

Charles D. Colman
Assistant Engineer

CDC:LR.
9/22/39

GRANITE STATE CONSTRUCTION CO.

2 MASCOMA STREET

LEBANON, NEW HAMPSHIRE

L. C. HORTON
TREASURER

September 12, 1939

New Hampshire Water Resources Board,
Concord, New Hampshire

Gentlemen:

On the accompanying plan is shown the location of a wooden dam at Lebanon, New Hampshire, owned by E. Cummings & Bros. Inc.

The present planking on the dam is in poor condition, some of the timbers in the bents are badly rotted, and the gate works at "B" are in poor physical condition as well as being valueless to this owner.

The owner proposes to reinforce or replace the defective timbers in the present bents; add new bents, as per sketch enclosed, in the area "C"; and replank the entire dam with new four-inch timber.

The works at "B" will not be removed but planks will be attached to the timbers at "D" in order to form a bulkhead above the crest of the dam that will divert the water toward the center of the stream.

The purpose of this dam is to supply power to the mills on the west side of the river through gates "A".

We request your approval of this work.

Very truly yours,

GRANITE STATE CONSTRUCTION COMPANY

L. C. Horton

L. C. Horton, Treasurer

9/13/39

Jacobson	
Holmgren ✓	
Return to	
Filed	
File No.	

LCH:D
enc.

C/125

MEMORANDUM

Case No. C125-C

TO: Richard S. Holmgren, Chief Engineer

RE: Case No. C125-C - Dam on Mascoma River in Lebanon - E.Cummings & Bros. Inc.

This dam is being repaired by the Granite State Construction Company, Mr. Horton Superintendent.

I visited the site accompanied by Mr. Horton and Mr. Eustace Cummings, President of the Cummings Brothers. Advise has been given to the Contractor and Mr. Cummings by Mr. Guy Williams on the addition to the structure.

A very careful check was made of all existing timber on the main frame of the dam and I designated those which I felt should be replaced. On the easterly side where the old gate structure was in very bad condition, the present spillway will be extended and a new concrete abutment built to deflect any water away from the buildings on the southeast side. Plans and specifications covering new work will be forwarded to you as soon as prepared.

I recommend that approval be given to the work subject to final inspection.

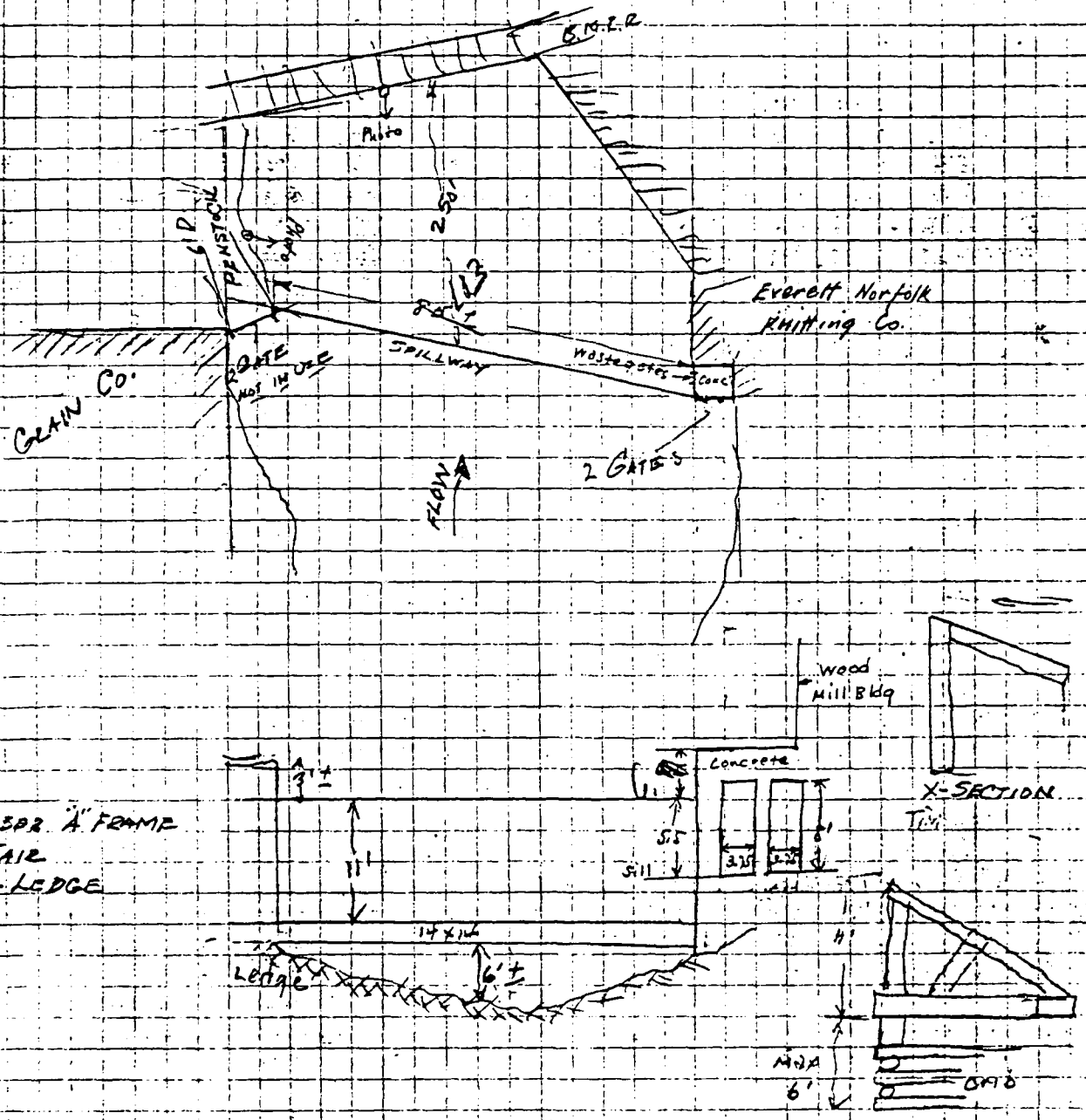
Respectfully submitted,

Charles D. Colman
Assistant Engineer

CDC:LR.
8/31/39

Mascoma River - Lebanon 134.05

EVERETT NORFOLK CO. 2nd FILM # 2 & 3



TYPE - TIMBER "A" FRAME
DITION - FAIR
UNDATION - LEDGE

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 134.05

Town Lebanon ✓ : County Grafton

Stream Mascoma River ✓

Basin-Primary Conn R ✓ : Secondar Mascoma R ✓

Local Name

Coordinates—Lat. 43° 40' – 8600 : Long. 72° 15' + 4000

GENERAL DATA

Drainage area: Controlled Sq. Mi.: Uncontrolled Sq. Mi.: Total 187 A.E Sq. Mi.

Overall length of dam 100 ✓ ft.: Date of Construction ~~1923~~ ? X Reb

Height: Stream bed to highest elev. 23 ✓ ft.: Max. Structure 20' ✓ - 17' ft.

Cost—Dam : Reservoir

DESCRIPTION "A" Frame– Timber ✓

Waste Gates

Type 2 - 4

Number 2 : Size 3' 4) ft. high x (2') 3 2.5 ft. wide

Elevation Invert 2' 11' ✓ : Total Area 8' - 7.5 total 15'5 sq. ft.

Hoist

Waste Gates Conduit

Number : Materials

Size ft.: Length ft.: Area sq. ft.

Embankment

Type

Height—Max. ft.: Min. ft.

Top—Width : Elev. ft.

Slopes—Upstream on: Downstream on

Length—Right of Spillway : Left of Spillway

Spillway

Materials of Construction Timber

Length—Total ft.: Net 85 ✓ ft.

Height of permanent section—Max. 20' ✓ ft.: Min. 17' ft.

Flashboards—Type : Height ft.

Elevation—Permanent Crest 568.4 : Top of Flashboard

Flood Capacity ~~1615~~ cfs.: ~~9.0~~ cfs/sq. mi.

Abutments

Materials:

Freeboard: Max. 6' 3' ✓ ft.: Min. ft.

Headworks to Power Devel.—(See "Data on Power Development")

OWNER ~~William Iselin & Co.~~ ? E. Cummings & Bros. ✓

REMARKS Power--- Knitting Mill Condition Fair 1936 Flood— 6' over crest

Tabulation By A A N & R L T Date Jan 3 1939

B&B21284

7206

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON WATER POWER DEVELOPMENTS IN NEW HAMPSHIRE

LOCATION AT DAM NO. 134.05

Town Lebanon : County Grafton

Stream Mascoma River

Basin-Primary Conn R : Secondary Mascoma

Local Name

GENERAL DATA

Head-~~Max.~~ ft.: ~~Min.~~ ft.: ~~Ave.~~ 17' ft.

Date of Construction 1923 : Use of Power Knitting Mill

Pondage ac. ft.: Storage ac. ft.

DESCRIPTION

Racks

Size of Rack Opening

Size of Bar : Material

Area: Gross Sq. Ft.: Net sq. ft.

Head Gates

Type

Number 2 : Size 8' ft. high x 3.75 ft. wide

Elevation of Invert 12' below crest Total Area sq. ft.

Hoist

Penstock

Number : Material

Size : Length

Turbines

Number 1 : Makers 40" Leffel Vertical

Rating HP. per unit 250 : Total Capacity 250 HP.

Max. Dement C.F.S., per unit : Total cfs.

Drive

Type

Generator

Number

Make G E- 240 V- 576 A AC 60 Cycle 164 R P M

Rating KW., per unit 192 ; Total Capacity K. W.

Exciter

Number 1 : Make Belt Driven

Rating-per unit : Total Capacity K. W.

OUTPUT—KWHRS

19.....	:	19.....	
19.....	:	19.....	
19.....	:	19.....	
19.....	:	19.....	
19.....	:	19.....	

OWNER William Iselin Co

Tabulation By A A N & R L T Date Jan 3, 1938

Rec'd 10-2-38

Jacobson	
Holmgren	✓
Coleman	
Returned	
Filed	
File No.	

WATER CONTROL COMMISSION

STATE OF NEW HAMPSHIRE

Concord, New Hampshire

October 14, 19 38

William Iselin & Co.,
Lebanon N H

RE: Iselin & Co Dam. W. C. C. No. 134.05

Gentlemen:

In order that we may determine the magnitude and extent of the flood of September 21-24 just passed, we are requesting the various dam owners in the State to supply us with the following information:

1. Was this dam injured? Ans. No.

2. If so, to what extent? Ans.

3. Did all flashboards go out? Ans. No

4. What was the maximum height of water over the permanent crest of spillway? Ans. about 3ft.

5. At what day and hour did the maximum flood height reach your dam? Ans. ?

6. Any other interesting information regarding the flood or rain fall may be given on the back of this sheet, or attach sheets.

Will you please return this letter with as much information as you can give us as promptly as possible. A self-addressed envelope is attached hereto.

We thank you for your cooperation.

Very truly yours,

Richard S. Holmgren

Richard S. Holmgren
Chief Engineer

CDC:GMB
Enc.

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

134.05

BASIN Connecticut NO. ~~5-61-F1232~~ 173 USGS 164 PSC
RIVER Mascoma MILES FROM MOUTH 5.13 D.A.SQ.MI. 157 AE
TOWN Lebanon OWNER ~~Everett Nonfitt Co.~~ Wm Selin & Co. Factors foreclosed Dec 1933
LOCAL NAME OF DAM
BUILT 1923.1 DESCRIPTION Head Gate "A" Frame on top of Log crib headgate & penstock. Nam (1953) : E. Cummings & Bros (Tannery)

POND AREA-ACRES DRAWDOWN FT. POND CAPACITY-ACRE FT.
HEIGHT-TOP TO BED OF STREAM-FT. ~~44~~ 23 MAX. MIN.
OVERALL LENGTH OF DAM-FT. 100 MAX.FLOOD HEIGHT ABOVE CREST-FT.
PERMANENT CREST ELEV.U.S.G.S. 568.4 LOCAL GAGE
TAILWATER ELEV.U.S.G.S. 550.0 LOCAL GAGE
SPILLWAY LENGTHS-FT. ~~100~~ 85 FREEBOARD-FT. 6 ft 3' left
FLASHBOARDS-TYPE,HEIGHT ABOVE CREST None
WASTE GATES-NO. WIDTH MAX.OPENING DEPTH SILL BELOW CREST

1	2'	4	3
1	3'-6"	3	4

REMARKS Condition Fair 2 wheel gate 3.75 wide 8' opening 12' below crest
RC
1936 FLOOD 6' over crest

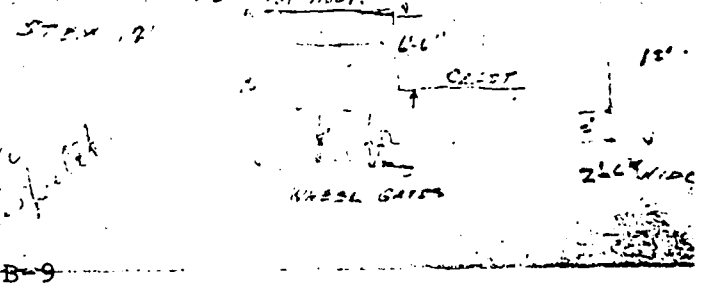
POWER DEVELOPMENT

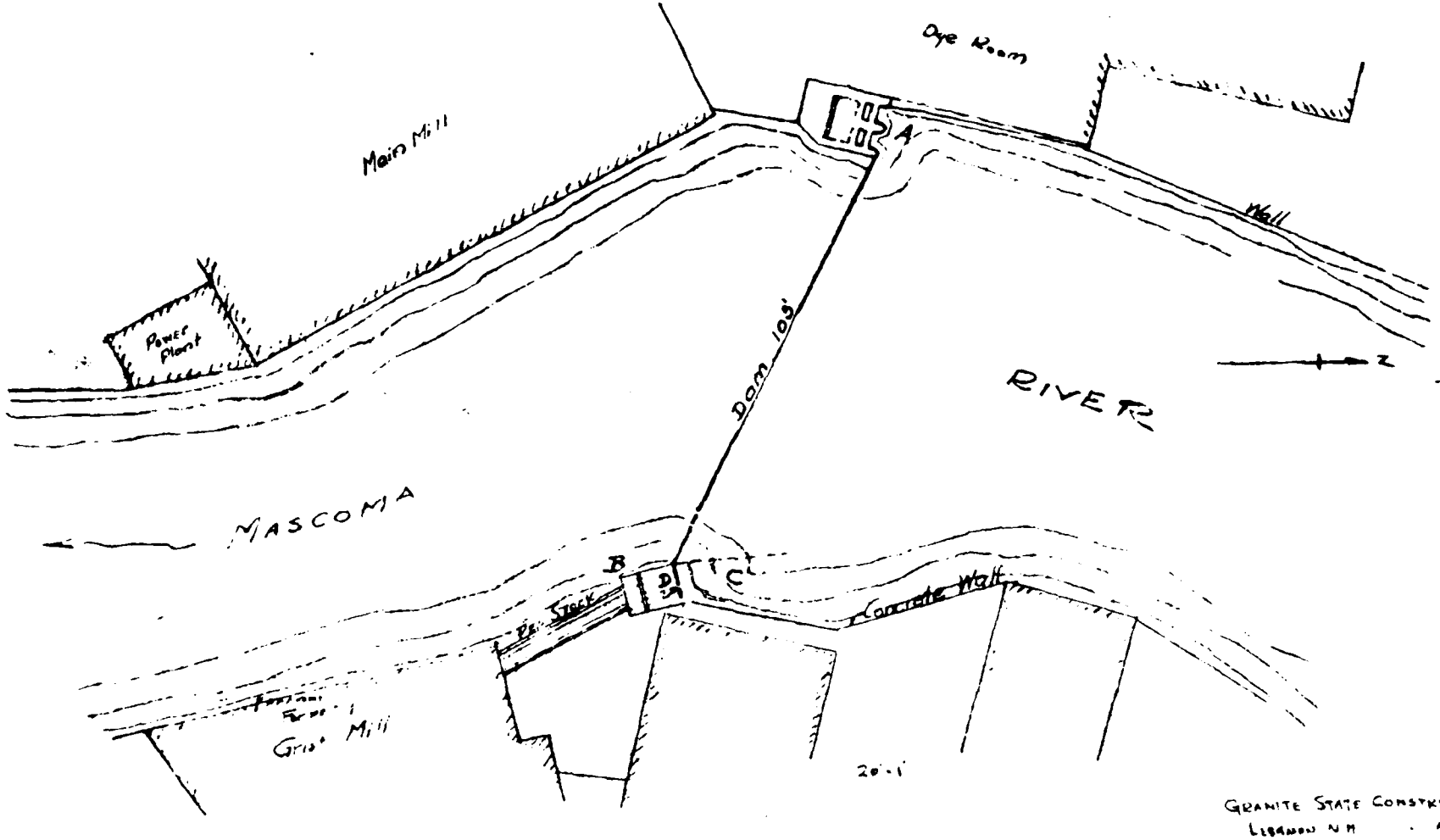
UNITS NO.	RATED HP	HEAD FEET	C.F.S. FULL GATE	KW	MAKE
	~~450~~	~~18.4 AE~~			
	~~200~~	~~17.5 and 18.66 PSC~~			
	~~450~~	~~18~~	~~USGS~~		
1	250	12	(Uses about 160 cfs)	197	40" Leffell vertical 164 RPM. GE 240V 576A AC! 3 ϕ Cocwle 164 RPM belt driven exciter

USE Power for Knitting Mill

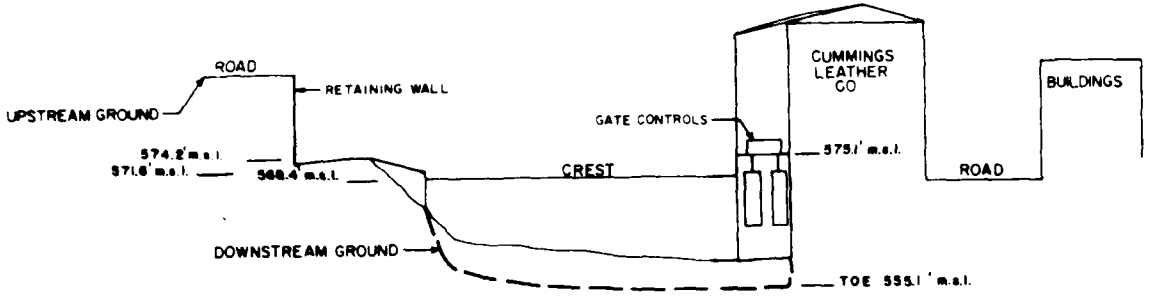
REMARKS Primary HP 90% time 188.7 ' Talked to Mr. Burgess Resident Agent now representing Wm. Iselin & Co. showed us blue prints and appraisal of value of plant giving details of installation.

DATE 1922 PSC 1931 AE
9/8/37 HR JHS

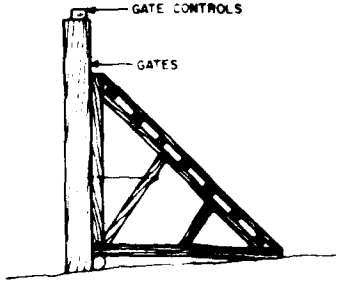




GRANITE STATE CONSTRUCTION Co
LEBANON N.H. August 1969



ELEVATION

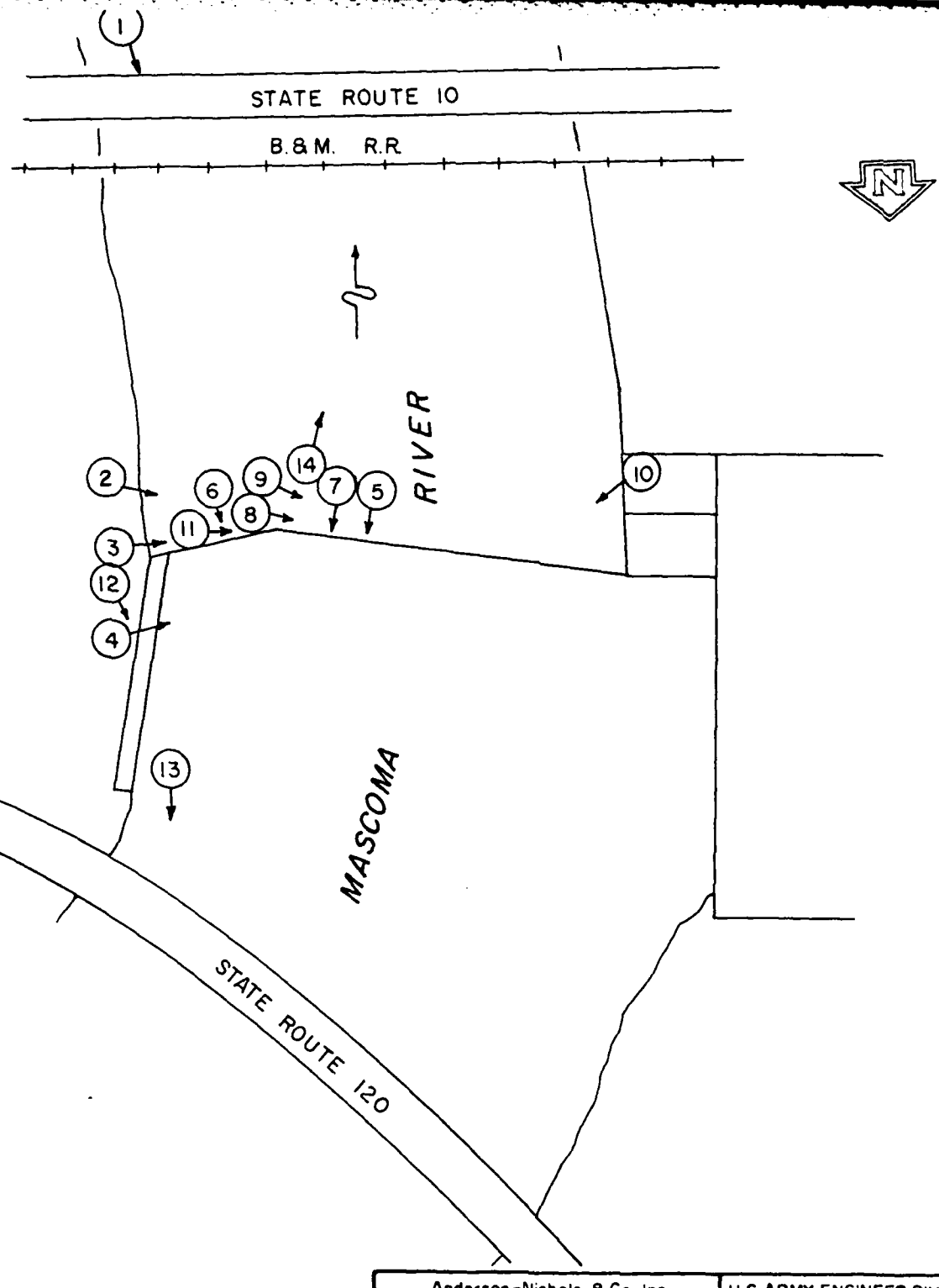


CROSS-SECTION

Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U S ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	
CUMMINGS DAM	
MASCOMA RIVER	NEW HAMPSHIRE
	SCALE NOT TO SCALE
	DATE FEBRUARY 1978

APPENDIX C

PHOTOGRAPHS



Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

CUMMINGS DAM
PHOTO INDEX

MASCOMA RIVER NEW HAMPSHIRE

SCALE: NOT TO SCALE

DATE: FEBRUARY 1979

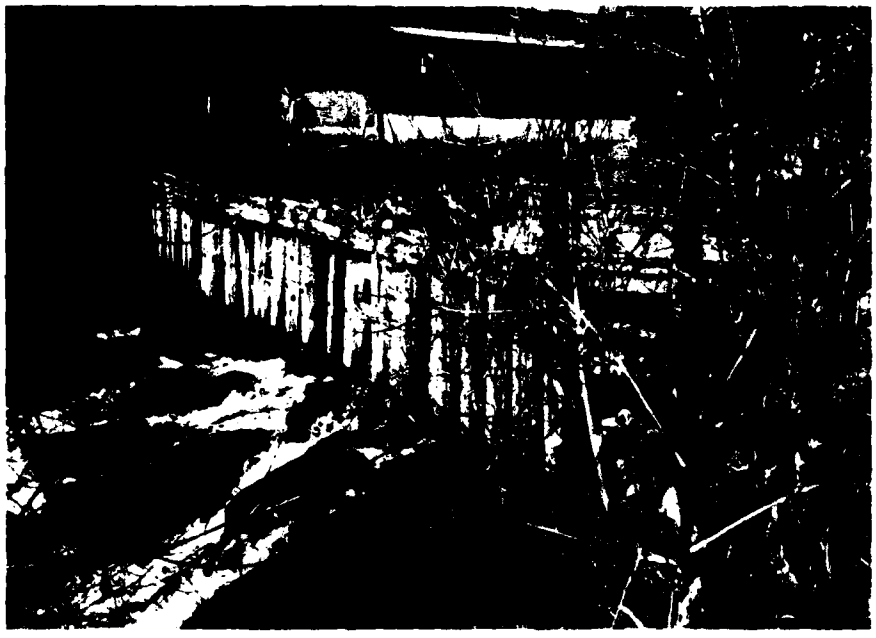


Figure 2 - Looking west along the downstream face of the dam.

Figure 3 - Looking west across the spillway crest from the east abutment.

Figure 4 - Looking at the upstream face of the spillway. Note the exposed deck and debris.

Figure 5 - Closeup of seepage through the deck.

Figure 6 - Leakage near the east end of the dam.

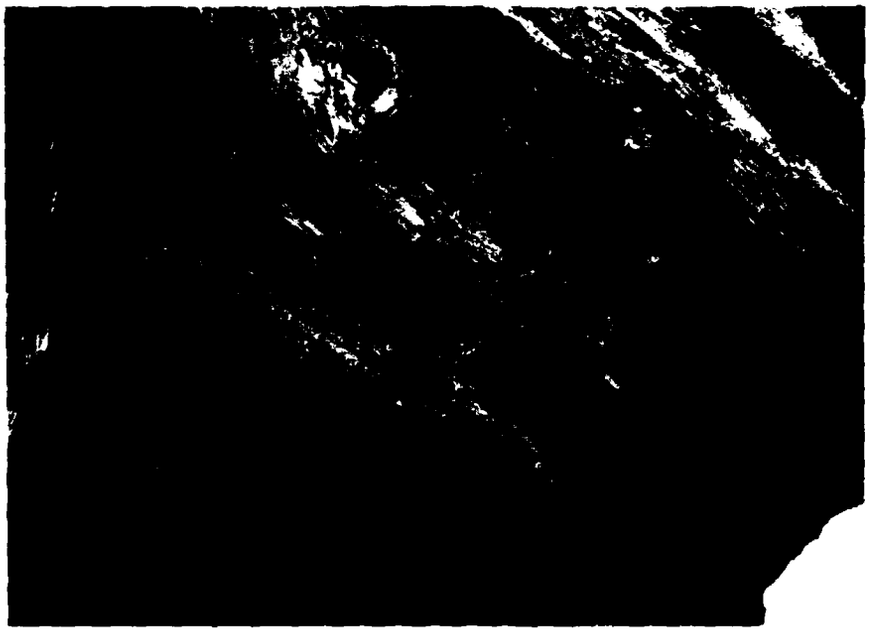


Figure 7 - Closeup of rotten beams.

Figure 8 - Closeup of the downstream face of the dam.

Figure 9 - Looking across the downstream face of the dam from the east toe.

Figure 10 - Looking at fallen support columns.

Figure 11 - Closeup of badly rusted bolts.

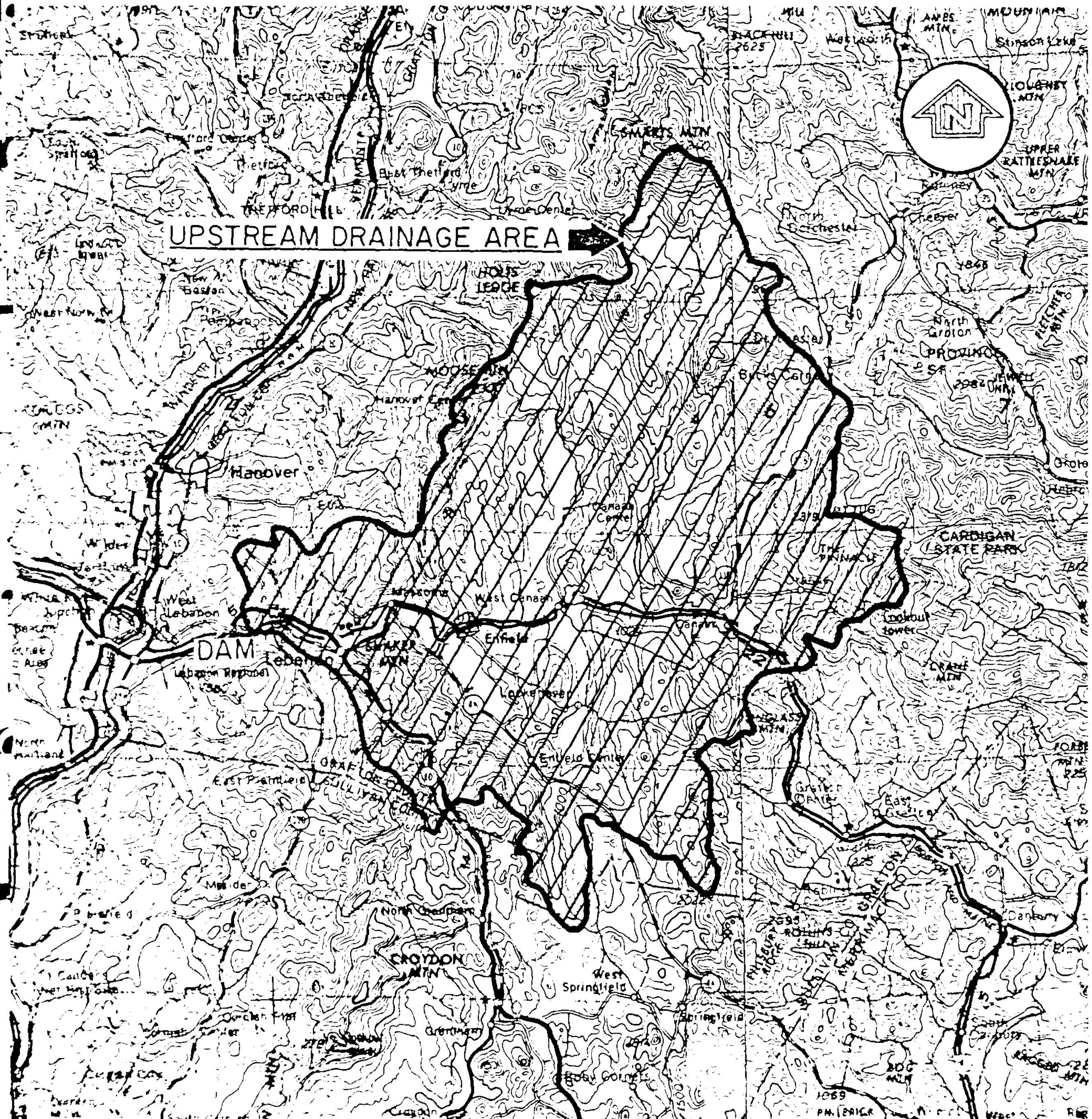
Figure 12 - Fractured training wall at east abutment.

Figure 13 - Looking upstream from the east abutment.

Figure 14 - Looking at the downstream channel from the toe of the dam.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS



NATIONAL PROGRAM OF INSPECTION
OF NON-FED. DAMS
CUMMINGS DAM
LEBANON, NEW HAMPSHIRE

REGIONAL VICINITY MAP

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

CONCORD, NH

SCALE IN MILES

0 5 10

MAP BASED ON U.S.G.S. 1:250,000 SERIES TOPOGRAPHIC MAPPING, GLENS FALLS, N.Y., VT., N.H. 1956 REVISED 1972, AND PORTLAND, ME., N.H. 1956 REVISED 1972.

APPENDIX D

HYDROLOGY & HYDRAULICS

CUMMINGS DAM

OVERTOPPING ANALYSIS

DA = 172 MI^2

SIZE CLASSIFICATION = SMALL

HAZARD CLASSIFICATION = SIGNIFICANT

TEST FLOOD = 1/4 PMF

CALCULATE PMF USING "PRELIMINARY GUIDANCE FOR ESTIMATING MAXIMUM PROBABLE DISCHARGES IN PHASE I DAM SAFETY INVESTIGATIONS, MARCH 1978.

AVERAGE SLOPE OF THE WATERSHED IS 29 FT/MI. DUE TO MASCOMA LAKE, LOCATED APPROXIMATELY 5 MILES UPSTREAM OF THE DAM AND OTHER STORAGE AREAS FURTHER UPSTREAM THE 'FLAT & COASTAL' CURVE WILL BE USED TO COMPUTE THE PMF.

PMF = 172 MI^2 X 350 CSM = 60,200 CFS

$1/4\ PMF = \frac{60,200}{4} = 15,050$ CFS

TEST FLOOD DISCHARGE = 15,050 CFS

REFER TO RATING CURVE: (p. 3)

WITH A DISCHARGE OF 15,050 CFS AN ELEVATION OF 579.0 MSL IS READ. SPILLWAY CREST = 568.4 MSL.

∴ THE SPILLWAY WILL BE OVERTOPPED BY APPROXIMATELY 10.6 FEET DURING THE TEST FLOOD (1/4 PROBABLE MAXIMUM FLOOD).

DETERMINE DISCHARGE RATING CURVE FOR THE DAM USING THE WEIR EQUATION $Q = CLH^{3/2}$, WHERE THE 'C' FOR THE DAM SPILLWAY CREST IS 3.8 & 'C' OVER ABUTMENTS AND OVERBANK IS 2.6.

TRIAL #1 @ 568.4 SPILLWAY CREST

$Q = 0$ CFS

TRIAL #2 @ 570.0

$Q = 3.8(103)(1.6)^{3/2} = 792$ CFS

TRIAL #3 @ 571.6 TOP OF LEFT ABUTMENT (MAXIMUM POOL)

$Q = 3.8(103)(3.2)^{3/2} = 2240$ CFS

TRIAL #4 @ 575.1 TOP OF RIGHT ABUTMENT

$Q = 3.8(103)(6.7)^{3/2} + 2.6(13)(2.3)^{3/2} + 2.6(5)(1)^{3/2} + 2.6(14)(1.6)^{3/2} = 6992$ CFS

TRIAL #5 @ 578.4

$Q = 3.8(103)(10)^{3/2} + 2.6(13)(5.6)^{3/2} + 2.6(14)(3.3)^{3/2} + 2.6(5)(4.3)^{3/2} + 2.6(14)(4.9)^{3/2} = 13,554$ CFS

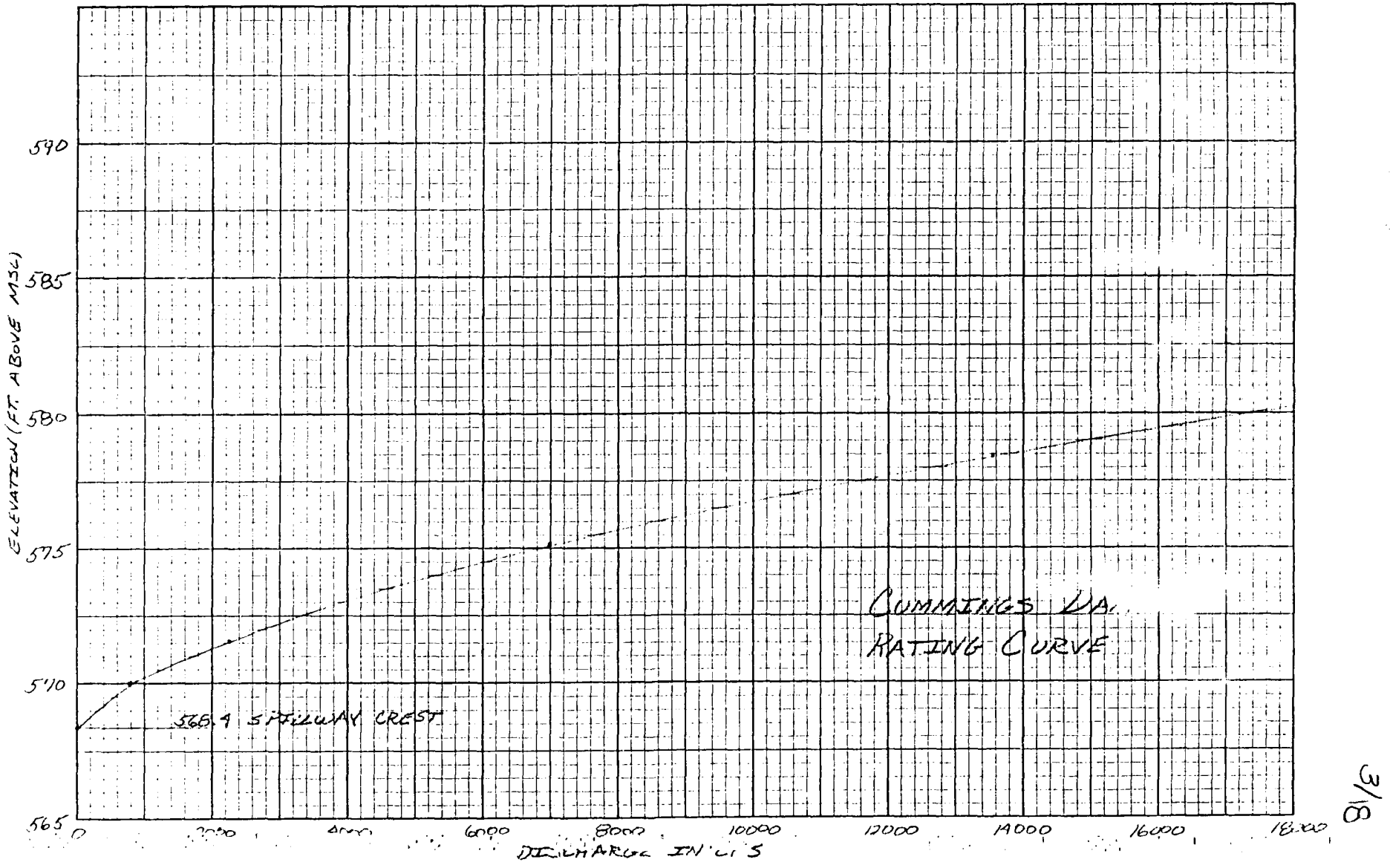
TRIAL #6 @ 583.4

$Q = 3.8(103)(15)^{3/2} + 2.6(13)(10.6)^{3/2} + 2.6(14)(8.3)^{3/2} + 2.6(5)(9.3)^{3/2} + 2.6(14)(9.9)^{3/2} = 26,278$ CFS

TRIAL #7 @ 588.4

$Q = 3.8(103)(20)^{3/2} + 2.6(13)(15.6)^{3/2} + 2.6(14)(13.3)^{3/2} + 2.6(5)(14.3)^{3/2} + 2.6(14)(14.9)^{3/2} = 41,653$ CFS

USE THE ABOVE TRIALS TO DEVELOP A DISCHARGE RATING CURVE FOR CUMMINGS DAM.



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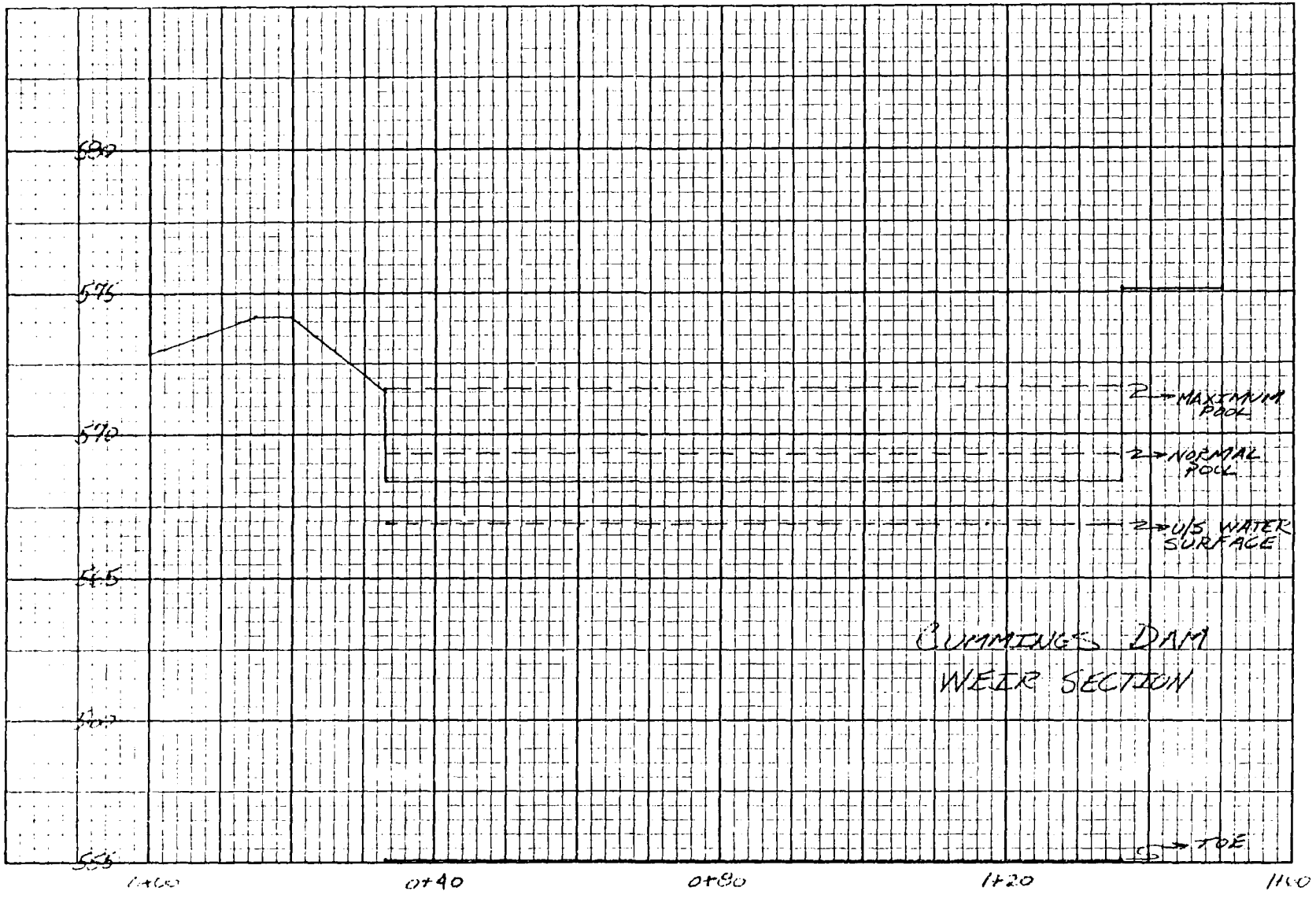

575
570
565
0+00
0+40
0+80
1+20
1+60
MAXIMUM POOL
NORMAL POOL
U/S WATER SURFACE
TOE
CUMMINGS DAM
WEIR SECTION

D-5

4/18

CUMMINGS DAM

BREACH ANALYSIS - TO DETERMINE DOWNSTREAM HAZARD CLASSIFICATION

FOR NORMAL POOL (USING MEAN ANNUAL FLOW): USING WATER RESOURCES DATA FOR NEW HAMPSHIRE AND VERMONT, WATER YEAR 1976, U.S. GEOLOGICAL SURVEY-DATA REPORT NH-VT-76-1, AUGUST 1977:

AT GAGE STATIONS ON MASCOMA RIVER

DA = 80.5 MI^2 - MEAN ANNUAL FLOW = 167 CFS = 2.07 CSM

DA = 153.0 MI^2 - MEAN ANNUAL FLOW = 323 CFS = 2.11 CSM

DUE TO THE UPSTREAM STORAGE OF MASCOMA LAKE, A 2.11 CSM VALUE IS APPLIED TO DA @ CUMMINGS DAM. (DA = 172 MI^2). ∴ MEAN ANNUAL FLOW = 172 X 2.11 = 363 CFS

THIS GIVES ABOUT 0.9 FOOT DEPTH OVER THE SPILLWAY

$$Q_{P_1} = 8/27\, W_b \sqrt{g}\, y_o^{3/2}$$

W_b = BREACH WIDTH

g = 32.2 FT/SEC²

y_o = POOL ELEV - U/S RIVER BED

569.3' MSL OR 0.9' OVER SPILLWAY CREST. UPSTREAM RIVER BED IS AT ELEVATION 558.3' MSL. ON THE DAY OF THE INSPECTION SEDIMENTATION WAS OBSERVED. SOME OF THIS SEDIMENTATION MAY BE CONSOLIDATED HOWEVER THE MOST CONSERVATIVE y_o WAS USED.

(a) CUMMINGS DAM

W_b = 103 X 0.90 = 91 FT.

y_o = 569.3 - 558.3 = 11 FT.

FROM EQUATION: Q = 2515 CFS

Q OVER DAM OTHER THAN BREACHED AREA: $Q = 3.8(62)(0.9)^{3/2} = 201$ CFS

TOTAL BREACH Q_{11} = 2515 + 201 = 2716 CFS

FOR MAXIMUM POOL: MAXIMUM POOL ELEVATION = 571.6'

② CUMMINGS DAM

$W_b = 103 \times 0.40 = 41$ FT

$y_o = 571.6 - 558.3 = 13.3$ FT

FROM EQUATION: $Q = 3349$ CFS

Q OVER DAM OTHER THAN BREACHED AREA: $Q = 3.8(62)(3.2)^{3/2} = 1399$ CFS

TOTAL BREACH $Q_{P_1} = 3349 + 1399 = \underline{4693}$ CFS

USE A TYPICAL X-SECTION ALONG THE DOWNSTREAM REACH FROM THE DAM TO THE RTE 10 HIGHWAY BRIDGE 375 FT. DOWNSTREAM.

USING THE FOLLOWING MANNINGS EQUATION:

$$Q = {}^{1.49}/_{n} A R^{2/3} S^{1/2}$$

n = COMPOSITE "n" VALUE

A = AREA

R = A/P (WETTED PERIMETER)

S = SLOPE

LENGTH OF REACH = 375 FT

ELEVATION @ D/S TOE = 558.4'

ELEVATION @ END OF REACH = 537.0'

SLOPE = 0.0571

COMPOSITE "n" = 0.06

FOR A RECTANGULAR SECTION - $Q = {}^{1.49}/_{0.06} \cdot 61y \left[\frac{61y}{(61+2y)}\right]^{2/3} \cdot S^{1/2}$

TRIAL # 1 STAGE = 1' Q = 359 CFS

TRIAL # 2 STAGE = 2' Q = 1102 CFS

TRIAL # 3 STAGE = 5' Q = 4784 CFS

TRIAL #4 STAGE = 7.5' Q = 8987 CFS

USE THE ABOVE TRIALS TO ESTABLISH A DOWNSTREAM X-SECTION RATING CURVE

FOR NORMAL POOL:

TOTAL BREACH Q = 2716 CFS → STAGE = 3.4 FT

ANTECEDENT $Q = 3.8 \cdot 103 \cdot 0.9^{3/2} = 334$ CFS → STAGE = 0.9 FT

∴ THE INCREASE IN STAGE CAUSED BY A BREACH AT NORMAL POOL WOULD BE ≈ 2.5 FEET.

FOR MAXIMUM POOL:

TOTAL BREACH Q = 4693 CFS → STAGE = 4.9 FT

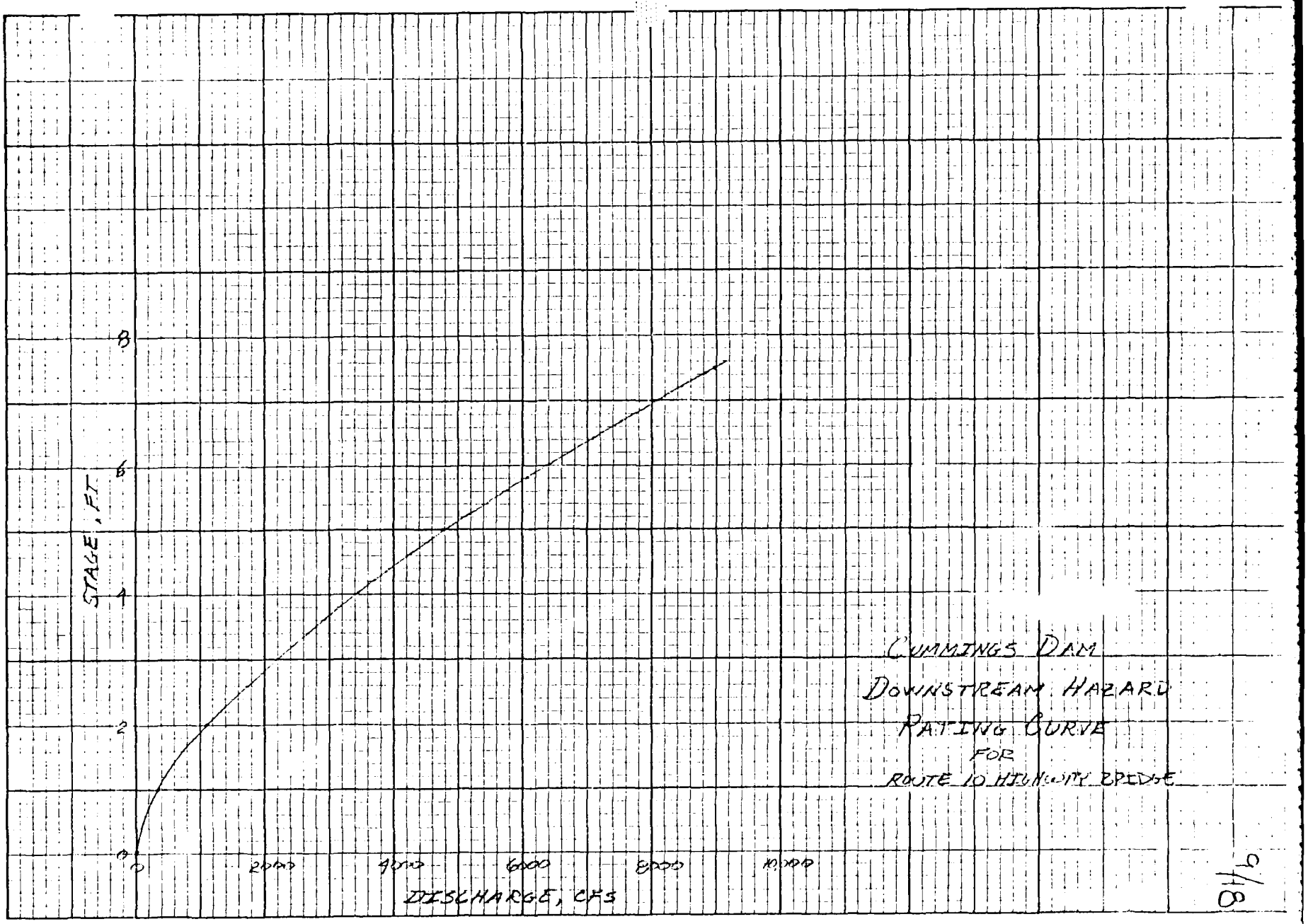
ANTECEDENT $Q = 3.8 \cdot 103 \cdot 3.2^{3/2} = 2290$ CFS → STAGE = 3.0 FT

∴ THE INCREASE IN STAGE CAUSED BY A BREACH AT MAXIMUM POOL WOULD BE ≈ 1.9 FEET

Although the breach at top of dam has a smaller increase over flood stage already present, the total stage is greater. Therefore the downstream hazard is evaluated on the basis of top-of-dam breach.

8/18

CUMMINGS DAM
D/S HAZARD ANALYSIS
X-SECTION @ RT. 10 HIGHWAY BRIDGE
10+30
10+00
9+70
20
15
10
5
0



CUMMINGS DAM
DOWNSTREAM HAZARD
RATING CURVE
FOR
ROUTE 10 HIGH CITY BRIDGE

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USE A TYPICAL X-SECTION ALONG THE DOWNSTREAM REACH FROM THE DAM TO THE SECTION 2600 FT DOWNSTREAM AT A DAM

USING THE FOLLOWING EQUATION:

$$Q = CLH^{3/2}$$

TRIAL #1 STAGE = 1' $Q = (3.4)(110)(1)^{3/2} = 374$ CFS

TRIAL #2 STAGE = 3' $Q = (3.6)(110)(3)^{3/2} = 2058$ CFS

TRIAL #3 STAGE = 5' $Q = (3.7)(110)(5)^{3/2} = 4550$ CFS

TRIAL #4 STAGE = 7' $Q = (3.8)(110)(7)^{3/2} = 7741$ CFS

USE THE ABOVE TRIALS TO ESTABLISH A DOWNSTREAM X-SECTION RATING CURVE

FOR NORMAL POOL:

BREACH $Q_{p_1} = 2716$ CFS $\rightarrow$ STAGE = 3.6'

w/ STAGE = 3.6' VOLUME$_1$ $\approx$ 18 AC-FT

BREACH Q_{p_2} (TRIAL) $= 2716\left(1 - \frac{18}{50}\right) = 1738$ CFS $\rightarrow$ STAGE = 2.7'

w/ STAGE = 2.7' VOLUME$_2$ $\approx$ 12 AC-FT

BREACH $Q_{p_2} = 2716\left(1 - \frac{(18+12)/2}{50}\right) = 1901$ CFS $\rightarrow$ STAGE = 2.8'

ANTECEDENT $Q = 334$ CFS $\rightarrow$ STAGE = 0.9'

$\therefore$ THE INCREASE IN STAGE CAUSED BY A BREACH AT NORMAL POOL WOULD BE $\approx$ 1.9 FEET

FOR MAXIMUM POOL:

BREACH $Q_{p_1} = 4693$ CFS $\rightarrow$ STAGE = 5.1'

W/STAGE = 5.1' VOLUME = 13 AC-FT

BREACH Q_{P_2} (TRIAL) = $4693\left(1-\frac{13}{80}\right)$ = 3930 CFS → STAGE = 4.6'

W/STAGE = 4.6' VOLUME = 9 AC-FT

BREACH $Q_{P_2} = 4693\left(1-\frac{13+9}{80}\right)^{1/2}$ = 4048 CFS → STAGE = 4.6'

ANTECEDENT Q = 2290 CFS → STAGE = 3.2'

∴ THE INCREASE IN STAGE CAUSED BY A BREACH AT MAXIMUM POOL WOULD BE ≈ 1.4 FEET.

USE A TYPICAL X-SECTION ALONG THE DOWNSTREAM REACH FROM THE DAM TO THE SLAYTON HILL ROAD BRIDGE

USING THE FOLLOWING EQUATION:

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

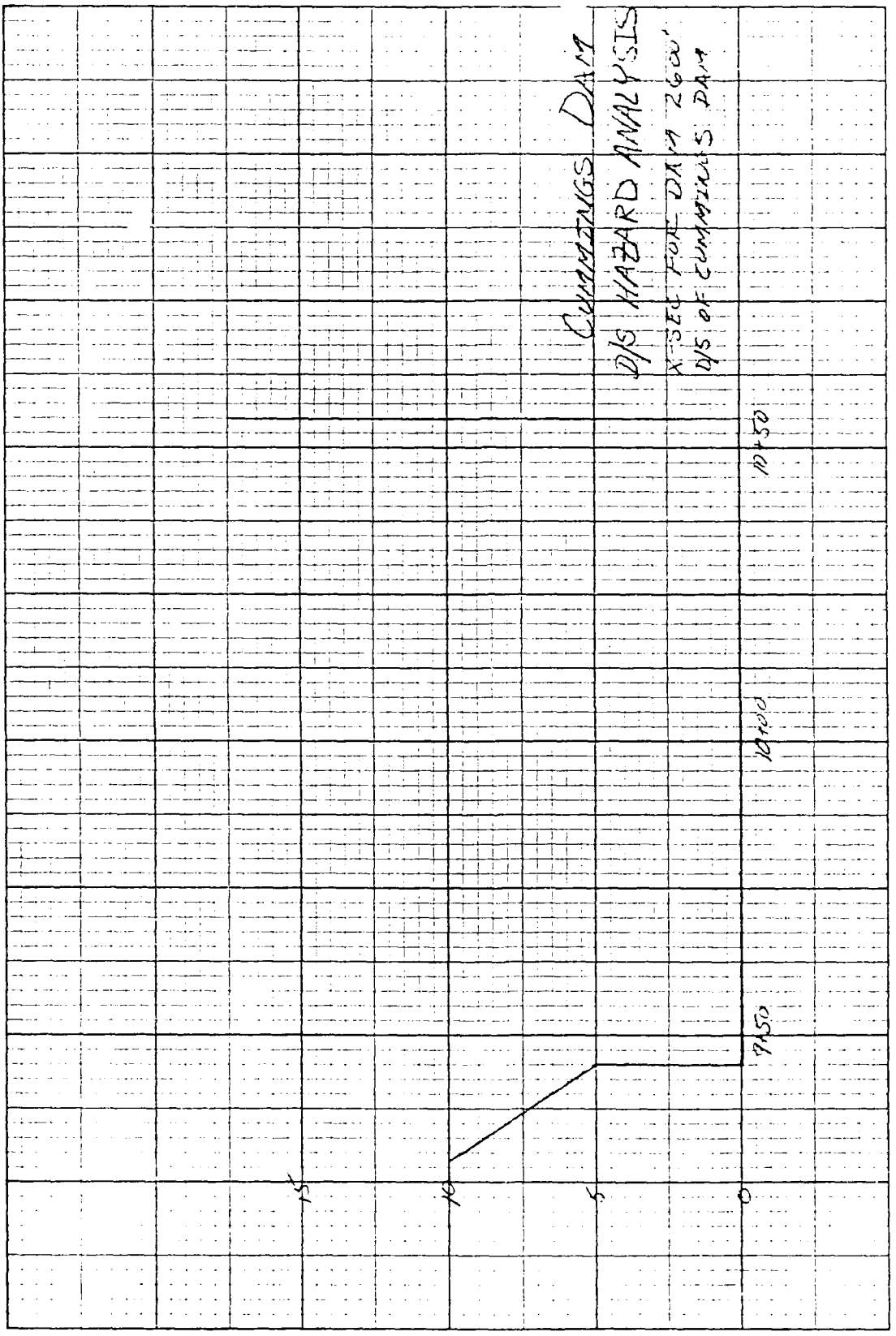
LENGTH OF REACH = 2170'

ELEVATION @ BEGINNING OF REACH = 537.0

ELEVATION @ END OF REACH = 519.0

SLOPE = 0.0083

COMPOSITE 'n' = 0.06


CUMMINGS DAM
D/S HAZARD ANALYSIS
X-SEC FOR DRG 26a'
D/S OF CUMMINGS DAM
15
10
5
0
1450
1400
1350

COMMINGS DAM
DOWNSTREAM HAZARD
RATING CURVE FOR
THE SECTION @ THE DAM
2600 FT DIS OF COMMINGS DAM

FOR A TRAPEZOIDAL SECTION - $Q = \frac{1.49}{0.06}(50 + 1.47y)y\left[\frac{(50+1.47y)\frac{y}{5}}{50+2y\sqrt{1+1.47^2}}\right]^{2/3}S^{1/2}$

TRIAL #1 STAGE = 1' Q = 113 CFS

TRIAL #2 STAGE = 2' Q = 363 CFS

TRIAL #3 STAGE = 5' Q = 1700 CFS

TRIAL #4 STAGE = 7.5' Q = 3419 CFS

USE THE ABOVE TRIALS TO ESTABLISH A DOWNSTREAM 1-SECTION RATING CURVE

FOR NORMAL POOL:

BREACH Q_{P_2} = 1901 CFS → STAGE = 5.3'

W/STAGE = 5.3' VOLUME$_2$ ≈ 11 AC-FT

BREACH Q_{P_3} (TRIAL) = $1901\left(1 - \frac{11}{50-15}\right)$ = 1303 CFS → STAGE = 4.3'

W/STAGE = 4.3' VOLUME$_3$ ≈ 8 AC-FT

BREACH $Q_{P_3} = 1901\left(1 - \frac{(11+8)/2}{50-15}\right)$ = 1385 CFS → STAGE = 4.4'

ANTECEDENT Q = 339 CFS → STAGE = 1.9'

∴ THE INCREASE IN STAGE CAUSED BY A BREACH AT NORMAL POOL WOULD BE ≈ 2.5 FEET

FOR MAXIMUM POOL:

BREACH Q_{P_2} = 4048 CFS → STAGE = 8.2

W/STAGE = 8.2' VOLUME$_2$ ≈ 7 AC-FT

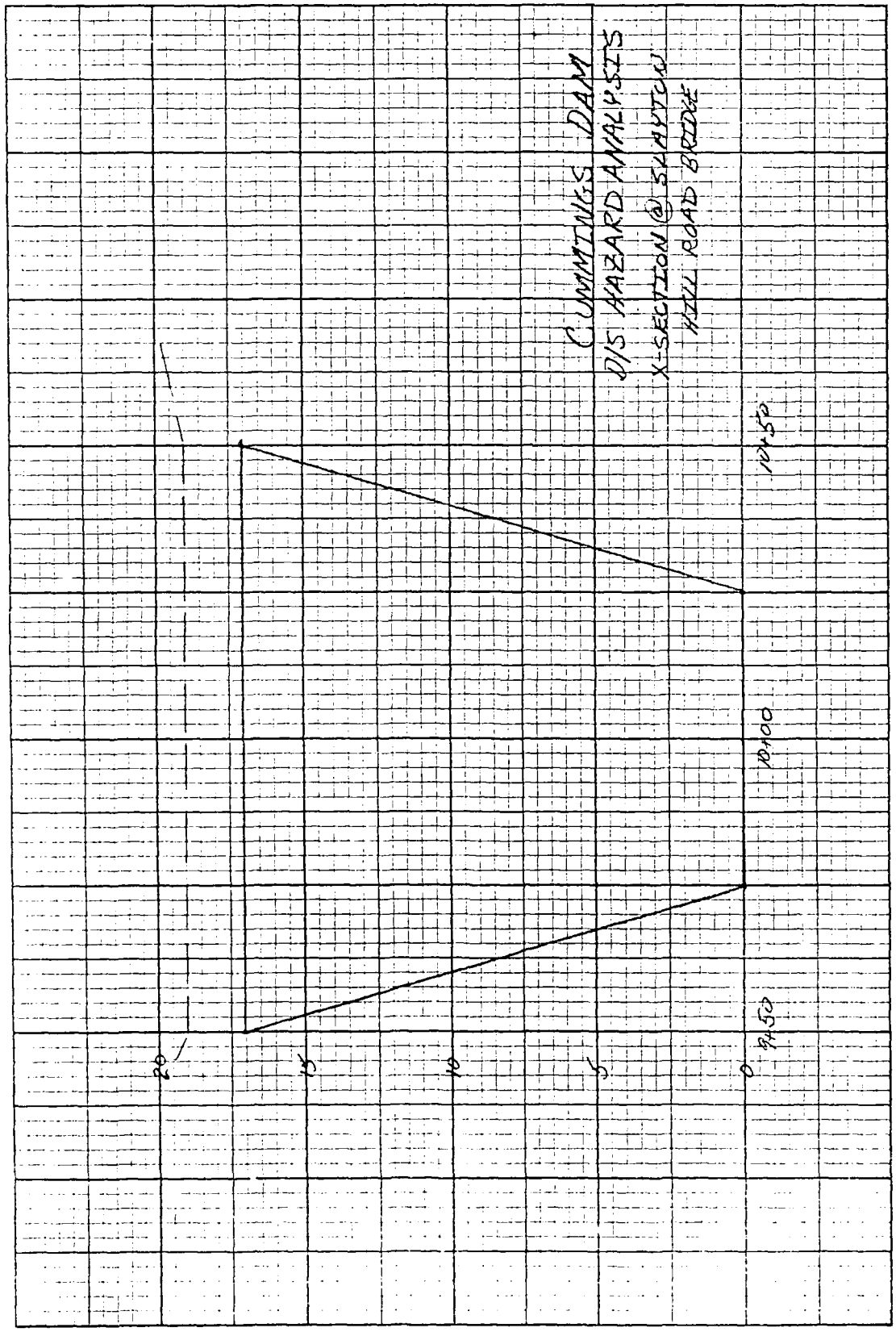
BREACH Q_{P_3} (TRIAL) = $4048\left(1 - \frac{7}{80-11}\right)$ = 3637 CFS → STAGE = 7.7'

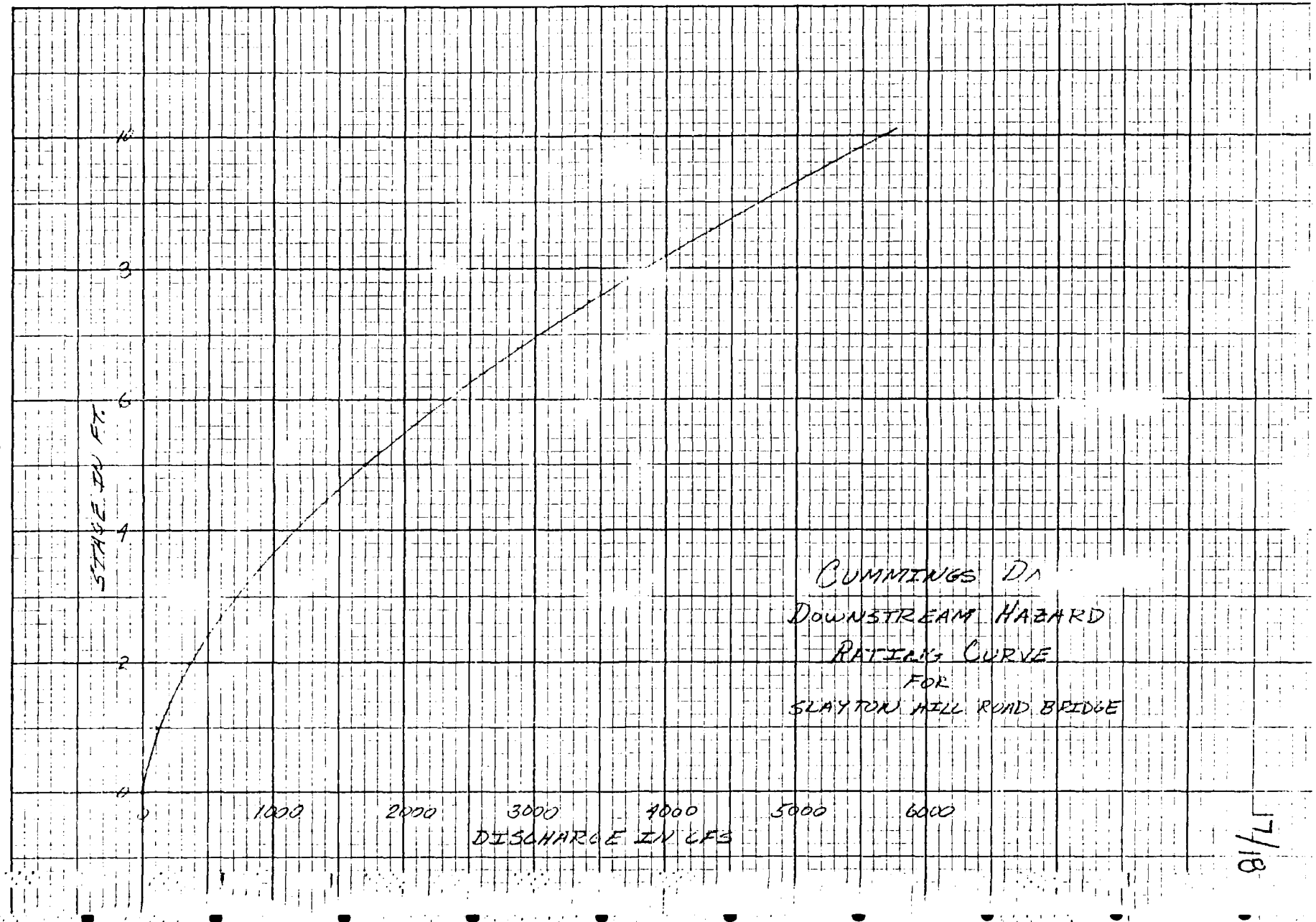
W/STAGE = 7.7' VOLUME$_3$ ≈ 6 AC-FT

BREACH $Q_{P_2} = 4048\left(1 - \frac{(7+6)/2}{80-11}\right)$ = 3667 CFS → STAGE = 7.8'

ANTECEDENT Q = 2240 cfs → STAGE = 5.9'

∴ THE INCREASE IN STAGE CAUSED BY A BREACH AT MAXIMUM F 2L WOULD BE ≈ .9


CUMMINGS DAM
D/S HAZARD ANALYSIS
X-SECTION @ SLAYTON
HILL ROAD BRIDGE
1W.S.EL.
10100
9450
0
5
10
15
20



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Cummings Dam - Gate Capacity

Data:
Opening - 8'H x 3.75'W
Two openings of same size
Invert elev. - 562.9' MSL

Calculate approx. gate capacity with pool @ top of dam - 571.6' MSL

$Q = CA\sqrt{2gh}$ ORIFICE EQUATION

$Q = (0.7)(30)(\sqrt{64.4 \times 4.7})$

$Q = 365$ cfs

2 gates $\therefore 365 \times 2 = \underline{730 \text{ cfs}}$

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR. DIST.	STATE	COUNTY	CONGR DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY | MO | YR
	15				02				CUMMINGS DAM	4338.6	7215.2	15FEB79

POPULAR NAME	NAME OF IMPOUNDMENT
CUMMINGS DAM	MASCOMA RIVER

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	CM	MASCOMA RIVER	LEBANON	0	9725

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE–FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE–FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
TIMBER	1922	S	20	17	80	45	FED	N	N	N	N	21FEB79

REMARKS
1=RECREATION 21=TIMBER CRIB-CONC FACE 22=REPAIRED 1939 23=INDUSTRIAL

D/S HAS	SPILLWAY LENGTH (FT.)	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
Y	195	U	103	22000												

OWNER	ENGINEERING BY	CONSTRUCTION BY
CUMMINGS LEATHER CORP		GRANITE STATE CONST CO

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
WATER RES BOARD	NHWR	NHWR	NHWR

INSPECTION BY	INSPECTION DATE DAY | MO | YR	AUTHORITY FOR INSPECTION
A PERSONICHOLS & COMPANY INC	05NOV78	PL 92-367

REMARKS
1938 RECONSTRUCTION

END

FILMED

8-85

DTIC